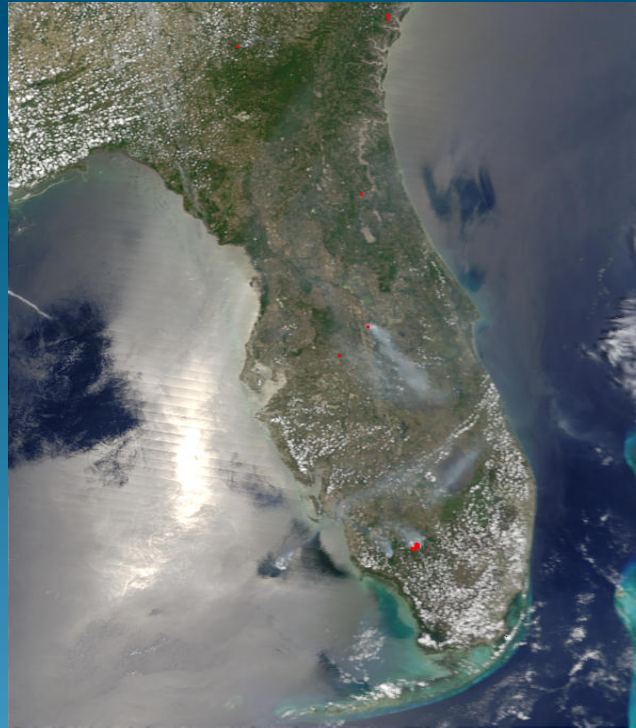# Asthma and Air Quality in the Presence of Fires: A Foundation for Public Health Policy in Florida

Collaborators

- Linda J. Young, Ph.D. (PI) University of Florida
- Sue Estes (Co-PI) USRA/NASA/MSFC
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- Bill Crosson, Ph.D. (Co-I) USRA/NASA/MSFC
- Maury Estes (Co-I) USRA/NASA/MSFC
- Jeff Luvall, Ph.D. (Co-I) NASA/MSFC
- Carol A. Gotway, Ph.D. (Co-I) CDC
- Greg Kearney, Ph.D. (Co-I) CDC
- Chris DuClos (Co-I) State of Florida
- Melissa Murray (Co-I) State of Florida
- Xaohui Xu, Ph.D. (Co-I) University of Florida
- Kenny Lopiano, University of Florida

Motivation

➤ Outdoor air quality and its associated impacts on respiratory problems in Florida are of public health significance.

➤ The outdoor air quality in Florida can be poor during periods of little rainfall or during the extended wildfire seasons, threatening persons with compromised respiratory systems each year.

➤ Increased levels of PM lead to increased ER visits and hospitalizations. The association between reduced air quality resulting from wildfires and/or prescribed burns and the incidence of asthma is unknown.

Objectives

➤ Develop high-quality spatial data sets of environmental variables

➤ Link these environmental data sets with public health data consisting of hospitalization admissions and ER visits associated with asthma and socio-demographic variables

➤ Develop spatial-temporal models of the association between asthma and air quality

➤ Provide the linked data sets and associated analyses to local, state and federal end-user groups

# Fine Particulate Matter Exposure Assessment
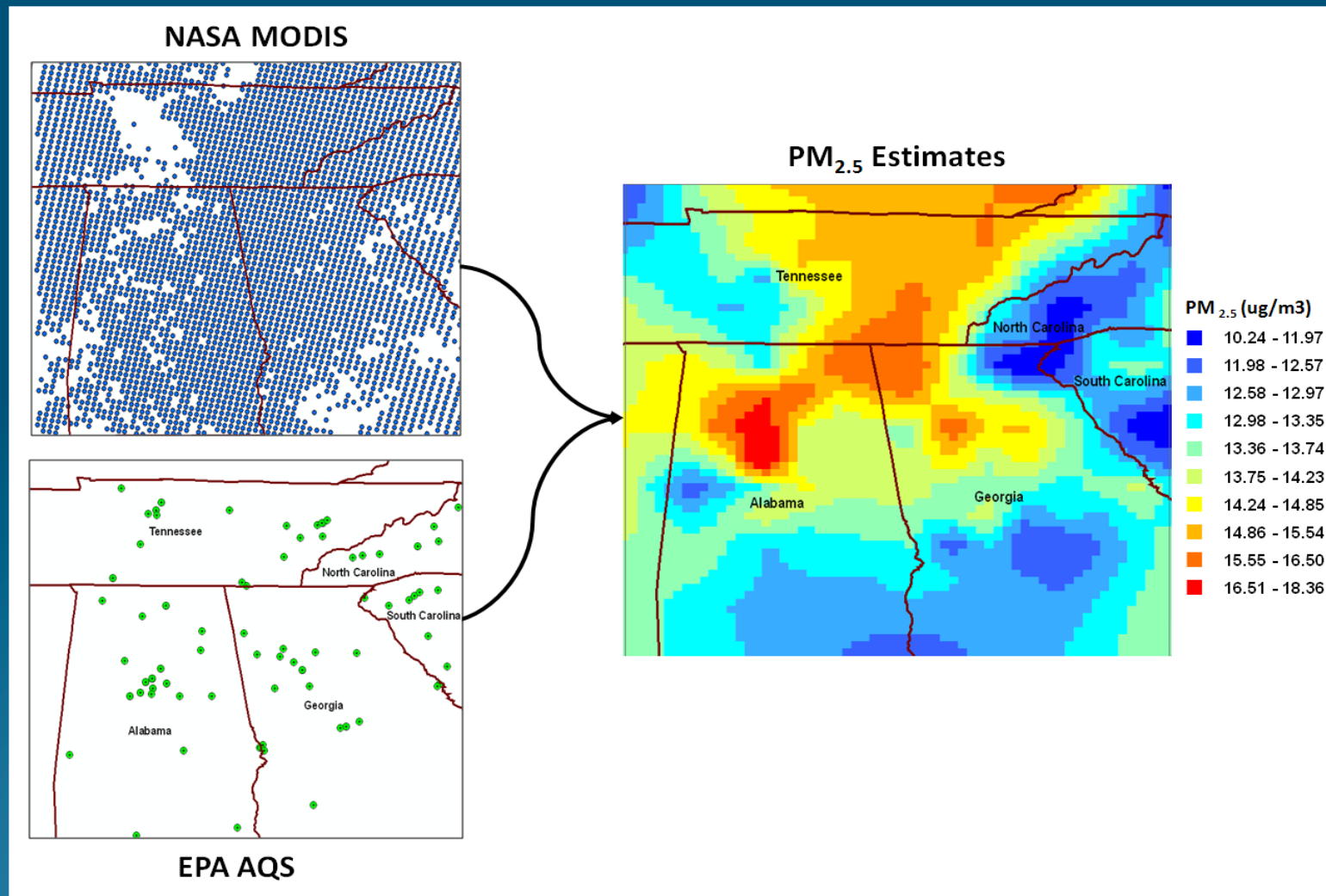
(Al-Hamdan et al., 2009)

Reference: Al-Hamdan, et al., 2009 M., Crosson, W., Limaye, A., Rickman, D., Quattrochi, D., Estes, M., Qualters, J., Sinclair, A., Tolsma, D, Adeniyi, K., Niskar, A. 2009. Methods for characterizing fine particulate matter using ground observations and remotely sensed data: potential use for environmental public health surveillance. *Journal of the Air and Waste Management Association*, 59, 865–881.
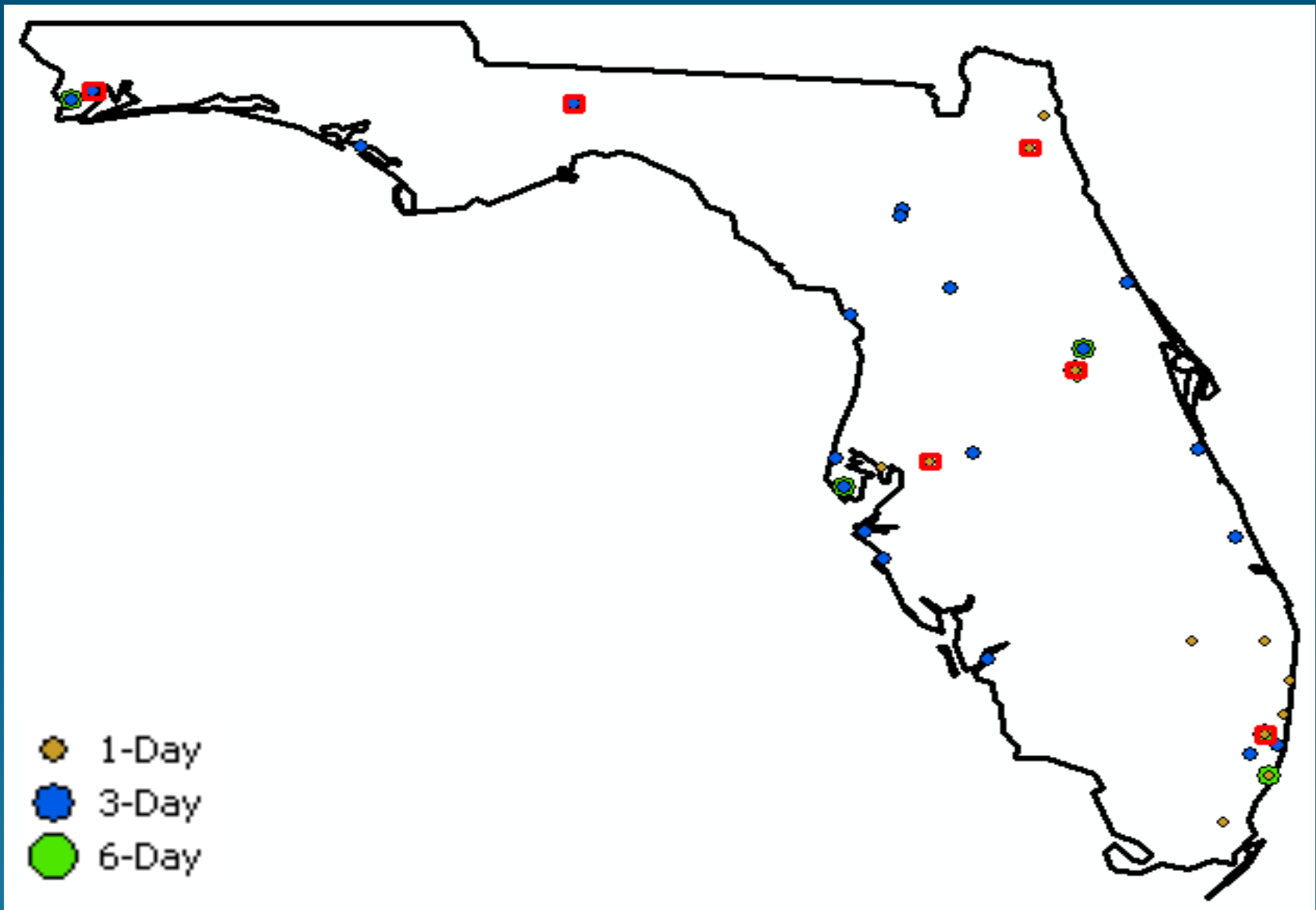
AQS PM2.5, February 18, 2007
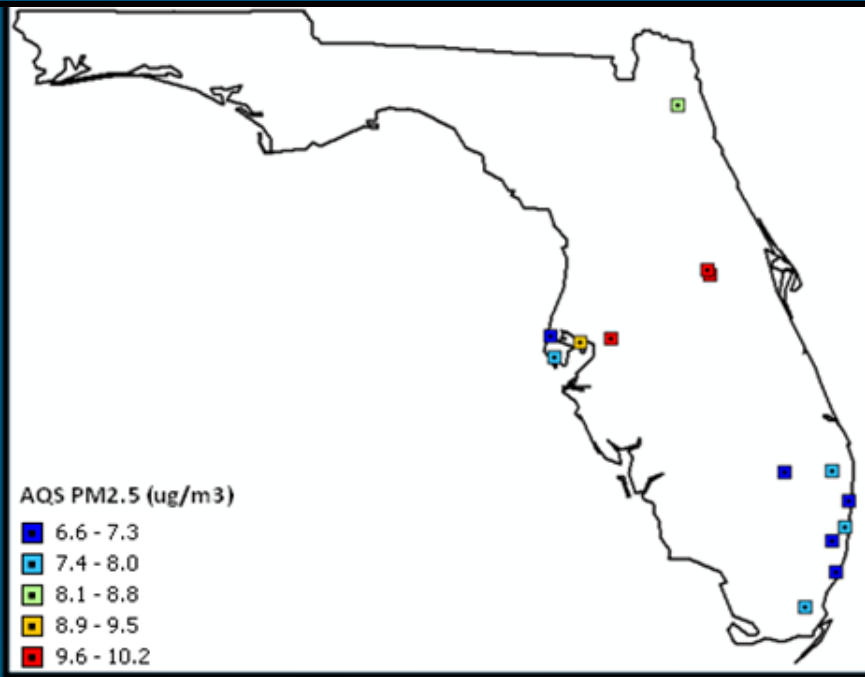
MODIS AOD, February 18, 2007
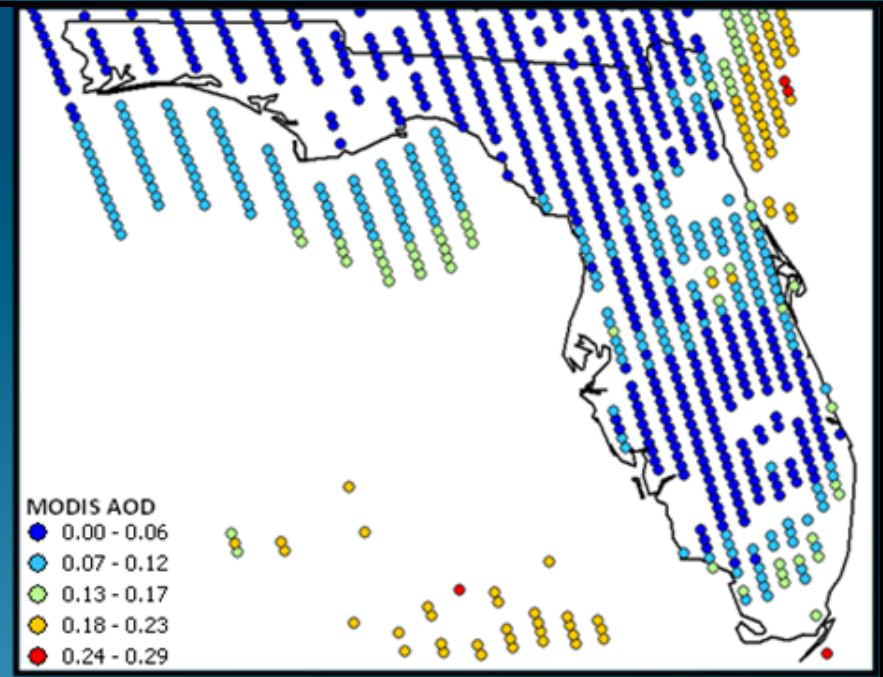
AQS PM2.5 monitors: (1) concentrated in urban areas
(2) observed every one to six days
NASA MODIS satellite sensor: (1) provides good spatial coverage
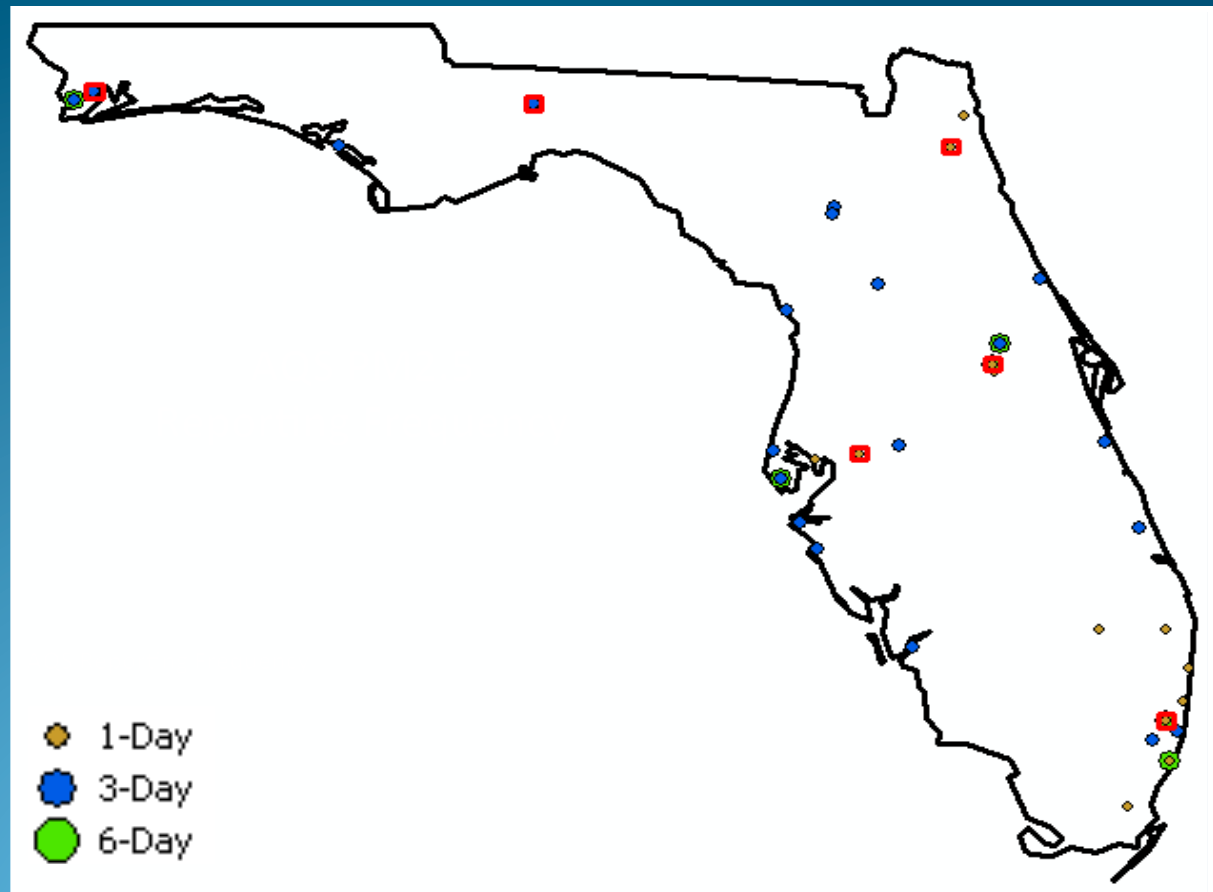(2) available only for clear-sky coverage

AQS PM2.5 Reporting Frequency

- 1-Day
- 3-Day
- 6-Day
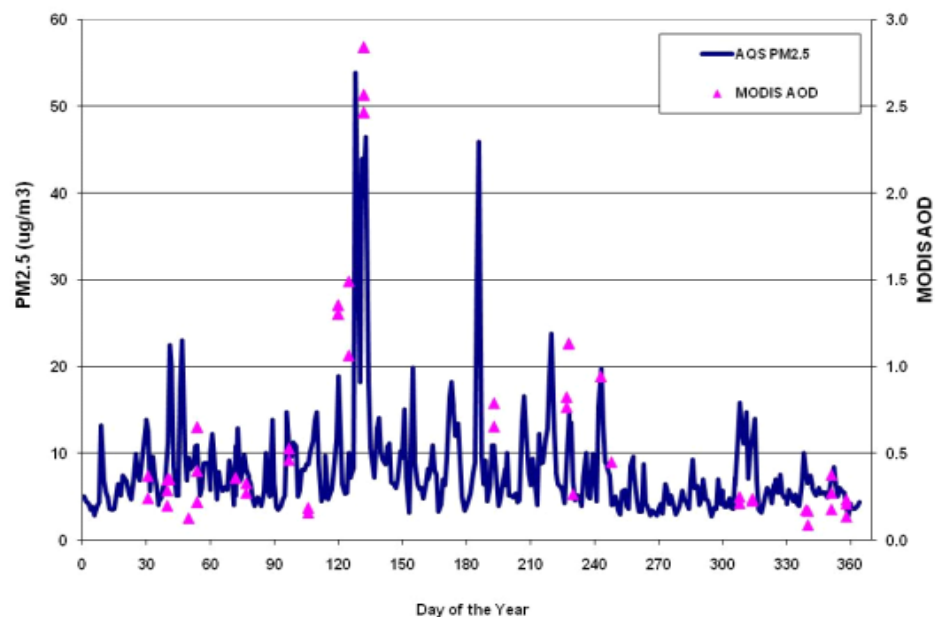
Combining AQS and MODIS Data

MODIS AOD data extracted for six AQS sites in diverse locations and settings

- Jacksonville
- Orlando
- Miami
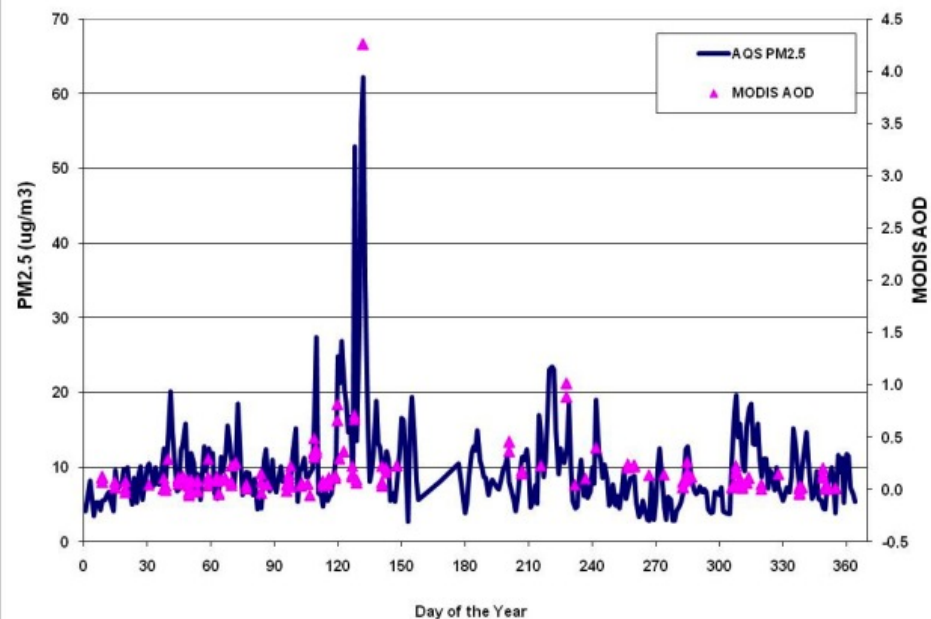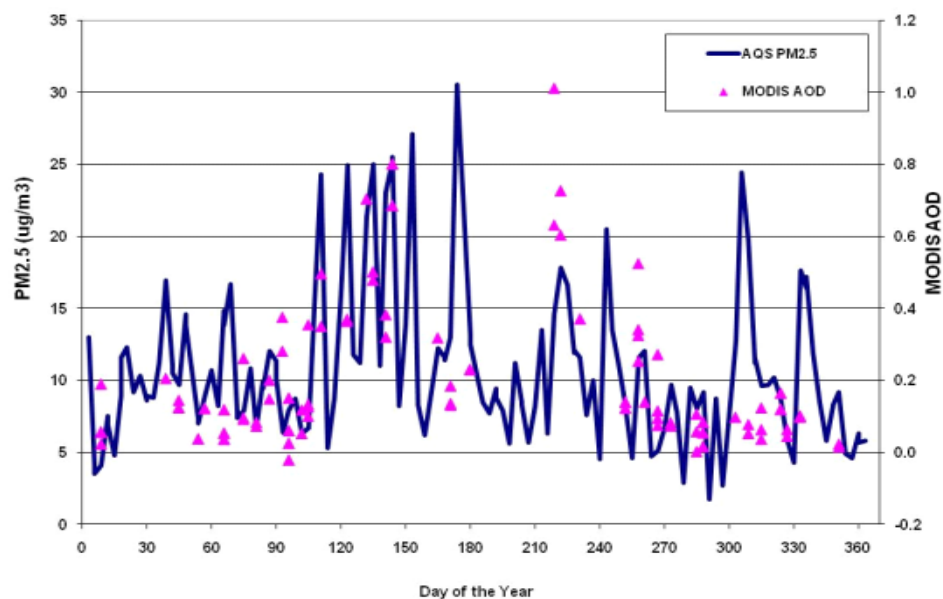- Tampa
- Tallahassee
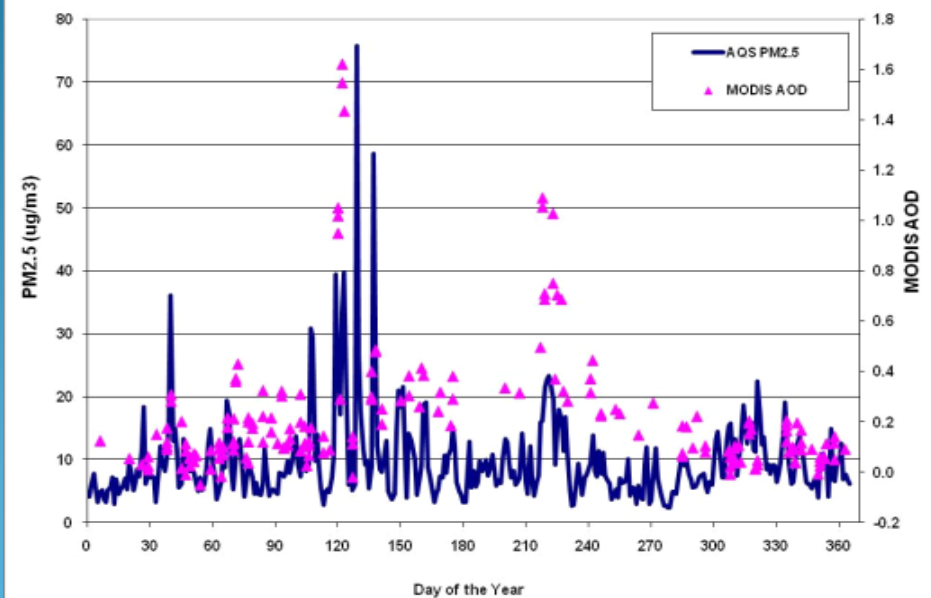- Pensacola

PM2.5 and AQUA MODIS AOD- 2007 (Miami, FL)

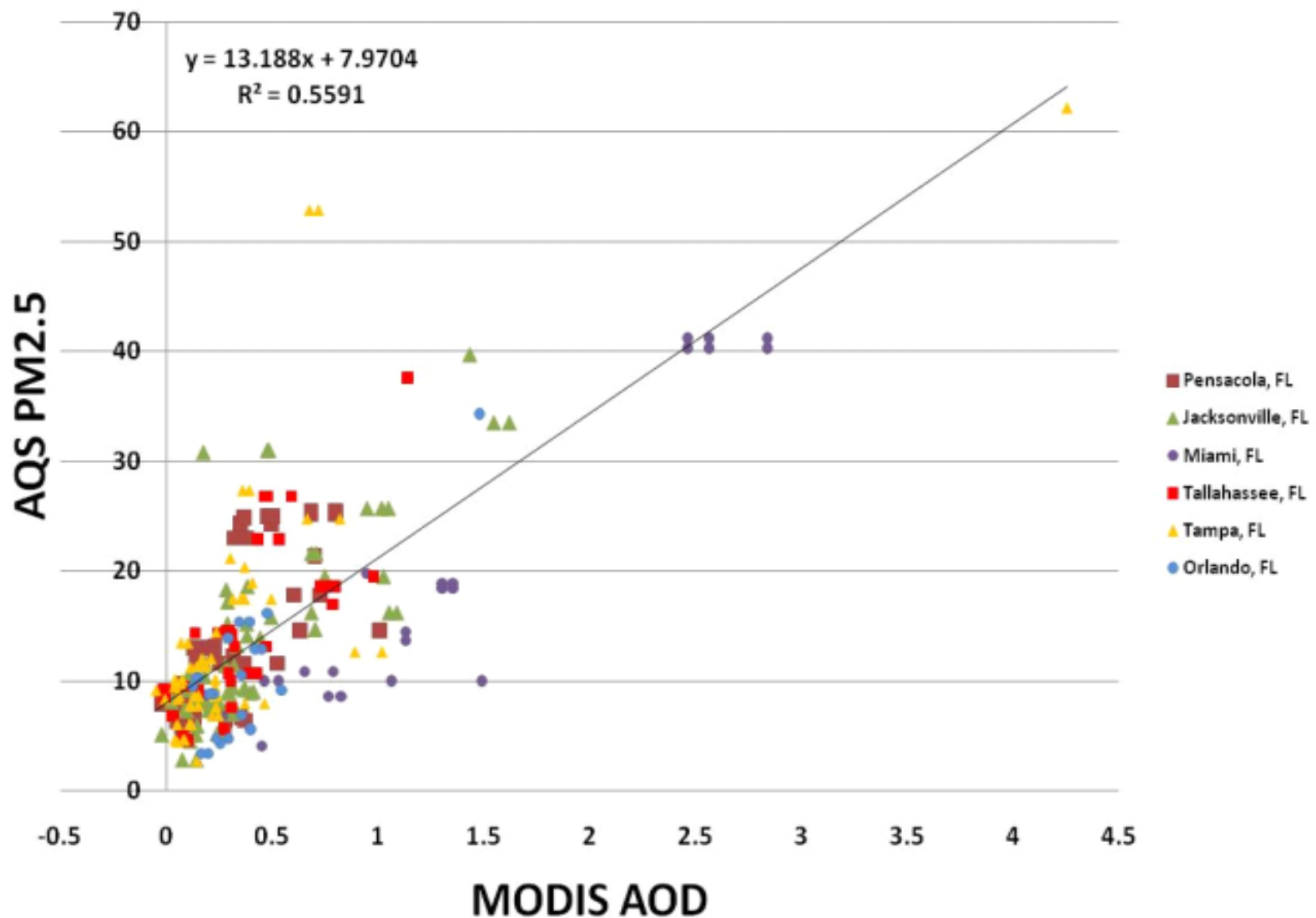PM2.5 and AQUA MODIS AOD- 2007 (Tampa, FL)

PM2.5 and AQUA MODIS AOD- 2007 (Pensacola, FL)

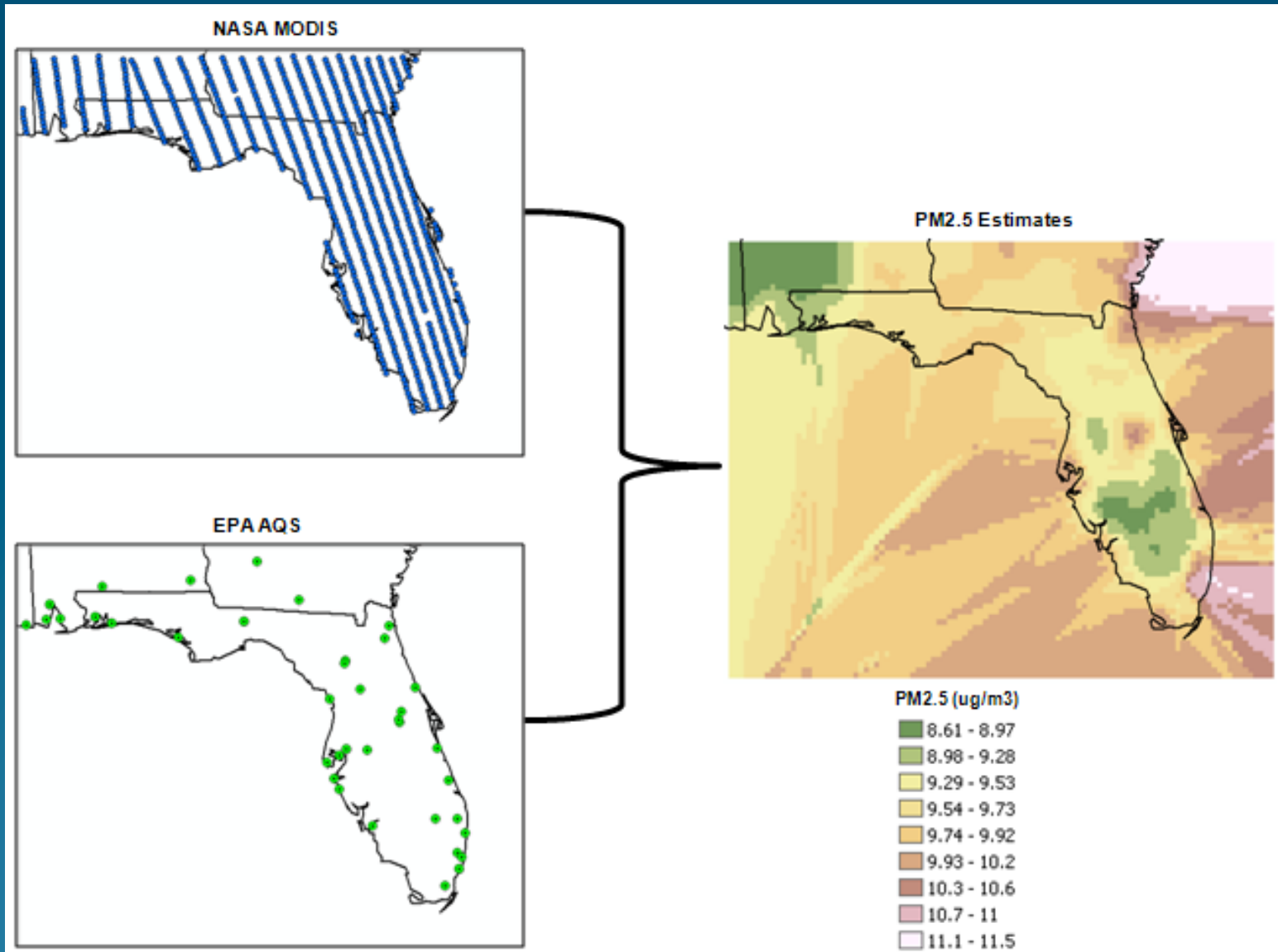PM2.5 and AQUA MODIS AOD- 2007 (Jacksonville, FL)
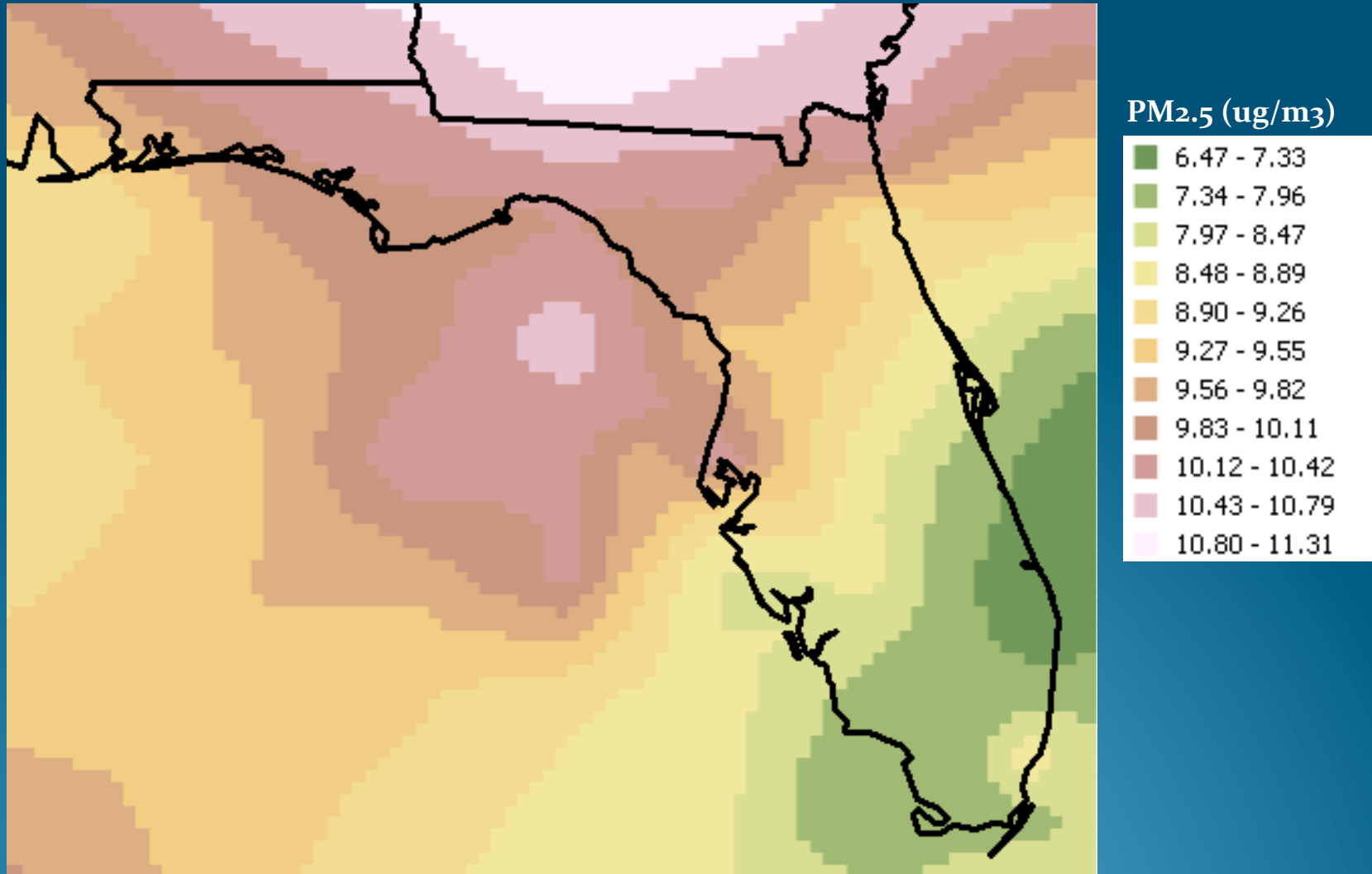
MODIS AOD vs AQS PM2.5

Merging AQS EPA and MODIS-derived PM2.5

April 16, 2007

PM2.5 B-spline Surfaces Year 2007 Composite

PM2.5 (ug/m3)

	6.47 - 7.33
	7.34 - 7.96
	7.97 - 8.47
	8.48 - 8.89
	8.90 - 9.26
	9.27 - 9.55
	9.56 - 9.82
	9.83 - 10.11
	10.12 - 10.42
	10.43 - 10.79
	10.80 - 11.31

Estimated PM$_{2.5}$

PM 2.5 - B-Spline
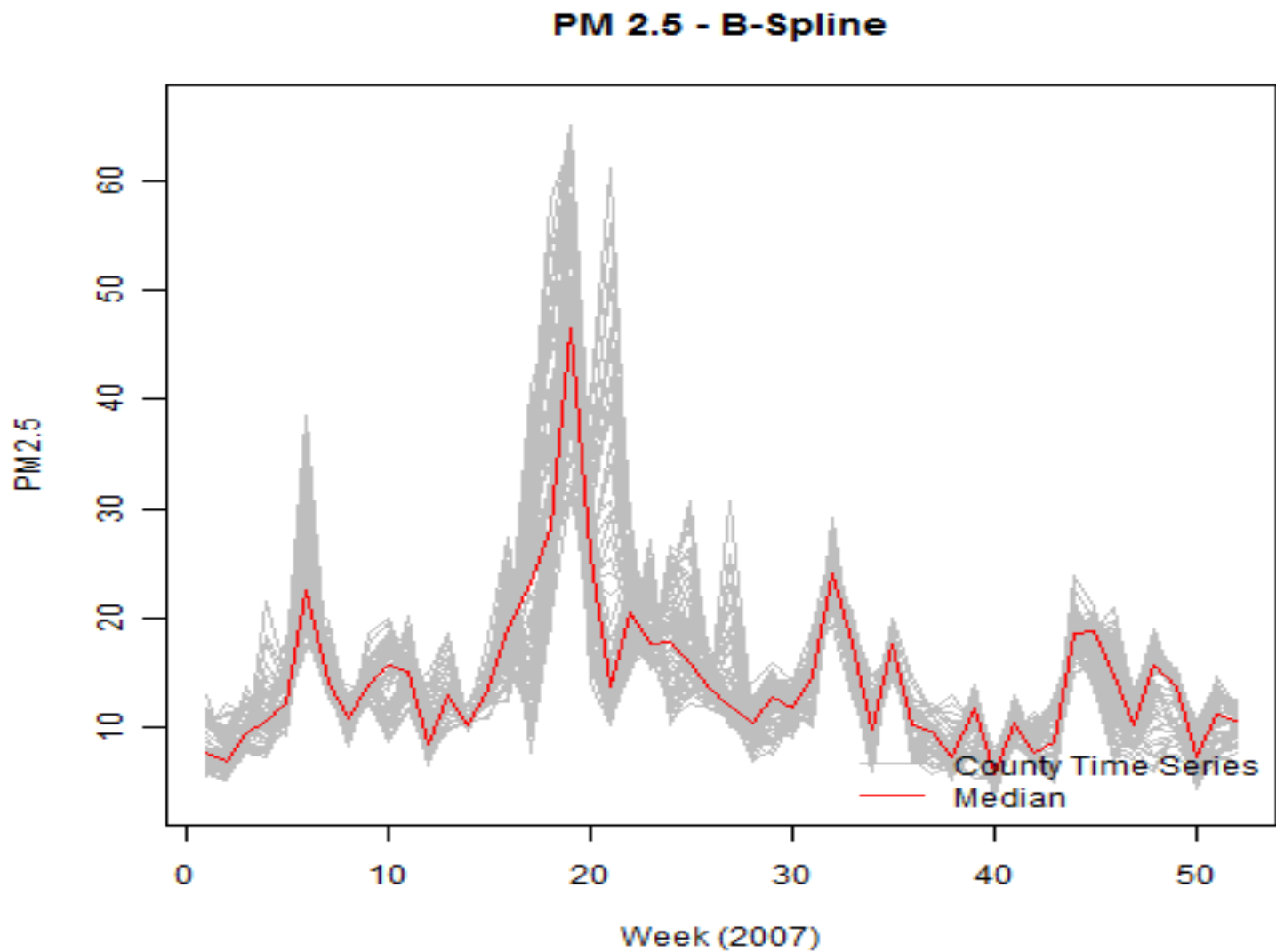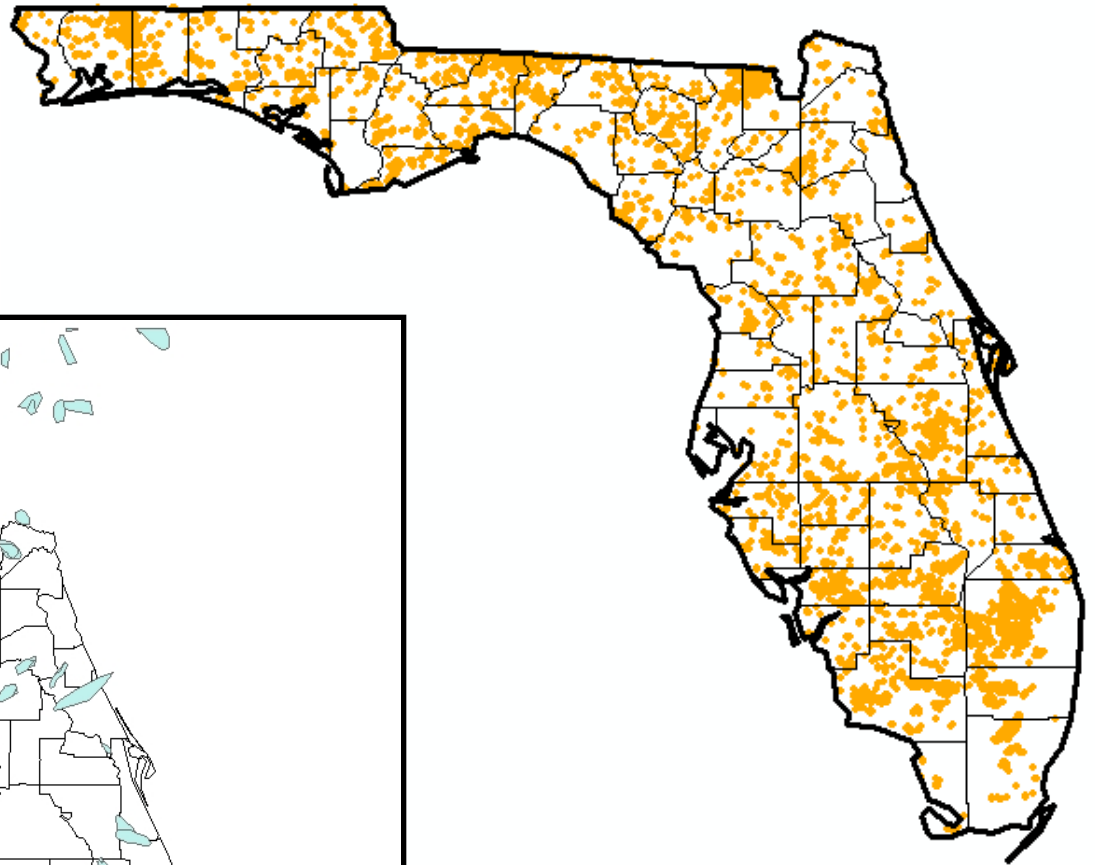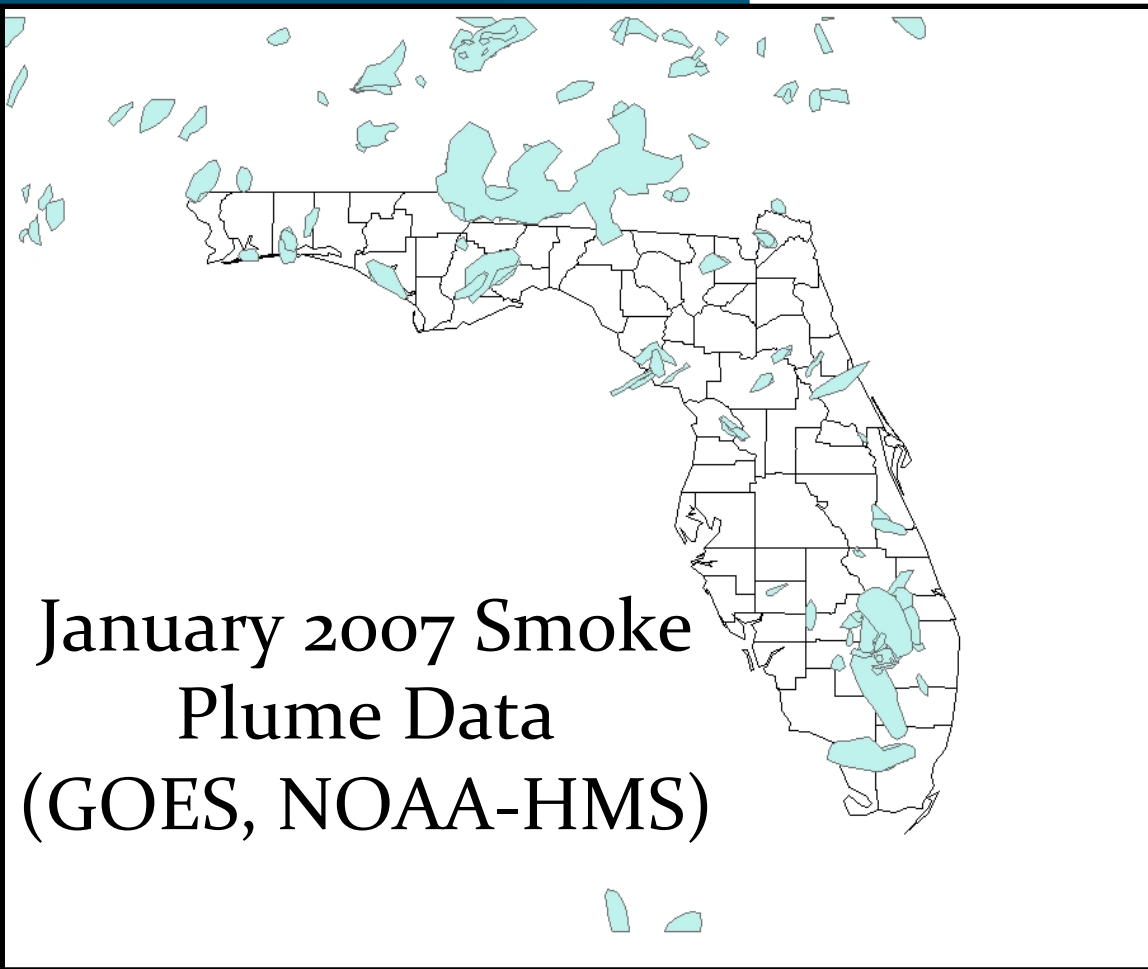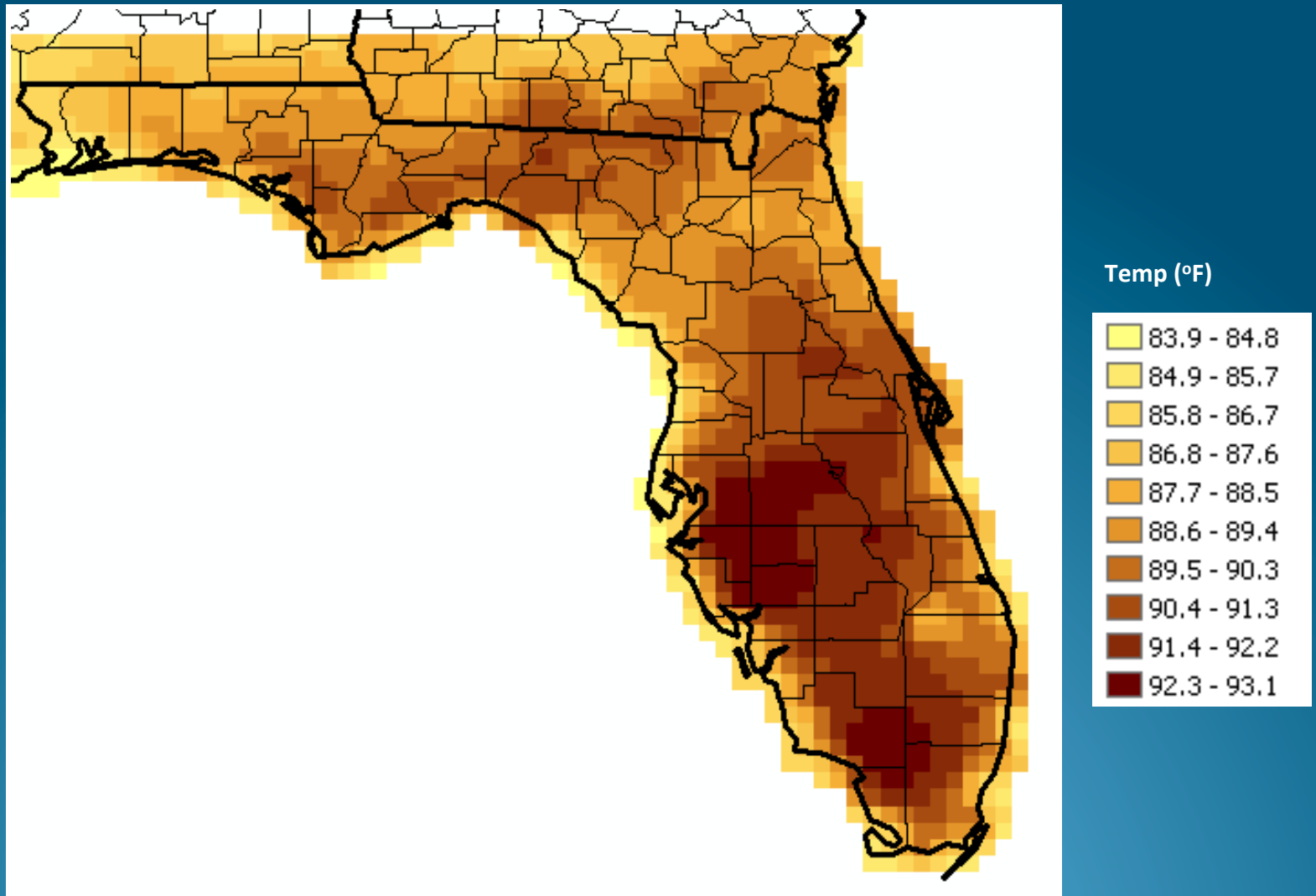
2007 MODIS Fire Detections

January 2007 Smoke Plume Data (GOES, NOAA-HMS)

Meteorological Data

NLDAS Daily Maximum Air Temperature on July 15, 2007

Temp (ºF)
- 83.9 - 84.8
- 84.9 - 85.7
- 85.8 - 86.7
- 86.8 - 87.6
- 87.7 - 88.5
- 88.6 - 89.4
- 89.5 - 90.3
- 90.4 - 91.3
- 91.4 - 92.2
- 92.3 - 93.1

Environmental Covariates

- Daily Measurements at County level
  - $PM_{2.5}$
  - Proportion of County Covered by Smoke
  - Proportion of County Covered by Fire
  - Relative Humidity
  - Windspeed
  - Maximum daily temperature
- Weekly Values: maximum over the week

Asthma Health Data
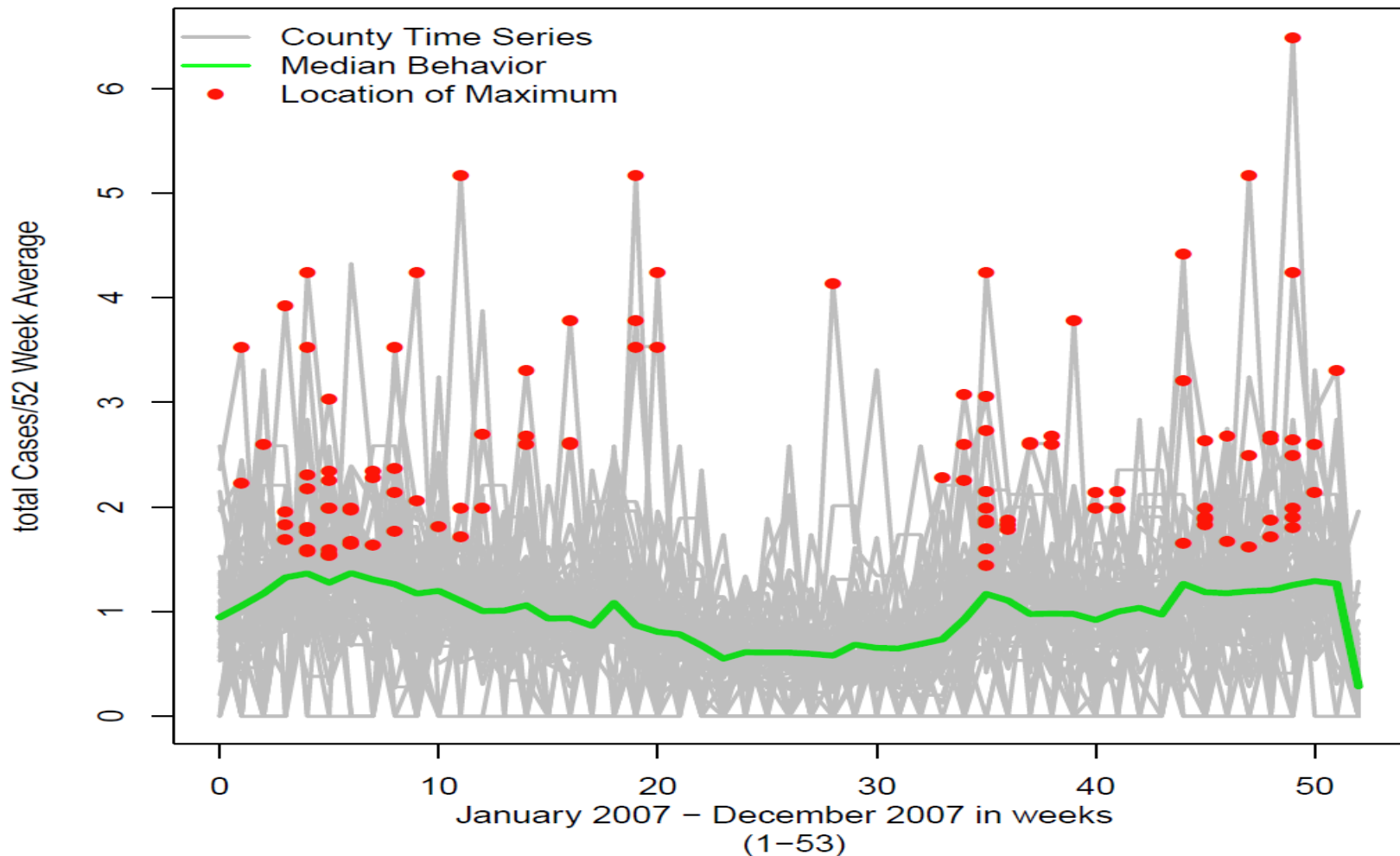
Poisson Regression Model

- Response – Total number of ER and Hospital cases for each age (<=18, 19-64, 65+) and sex (Female, Male)
- Offset – Size of population in age/sex combination as estimated by 2010 US Census
- Covariates crossed by age and sex
- Fixed effects for time
  - (A sin (week*π/26) + B cos (week* π /26)
- Random effects
  - County
  - Age*Sex*County
  - Week
- Backwards Elimination

Poisson Regression Model

- Factors having a significant 3-way interaction with age and sex
  - Maximum relative humidity
  - Maximum smoke
- Factors with a significant interaction with age
  - $PM_{2.5}$
  - Maximum temperature
  - Maximum wind speed
  - Temporal Effects
- Factors with a significant interaction with sex
  - Cosine term of temporal effect
  - PM2.5
  - Maximum temperature

Assessing the Fit of the Model
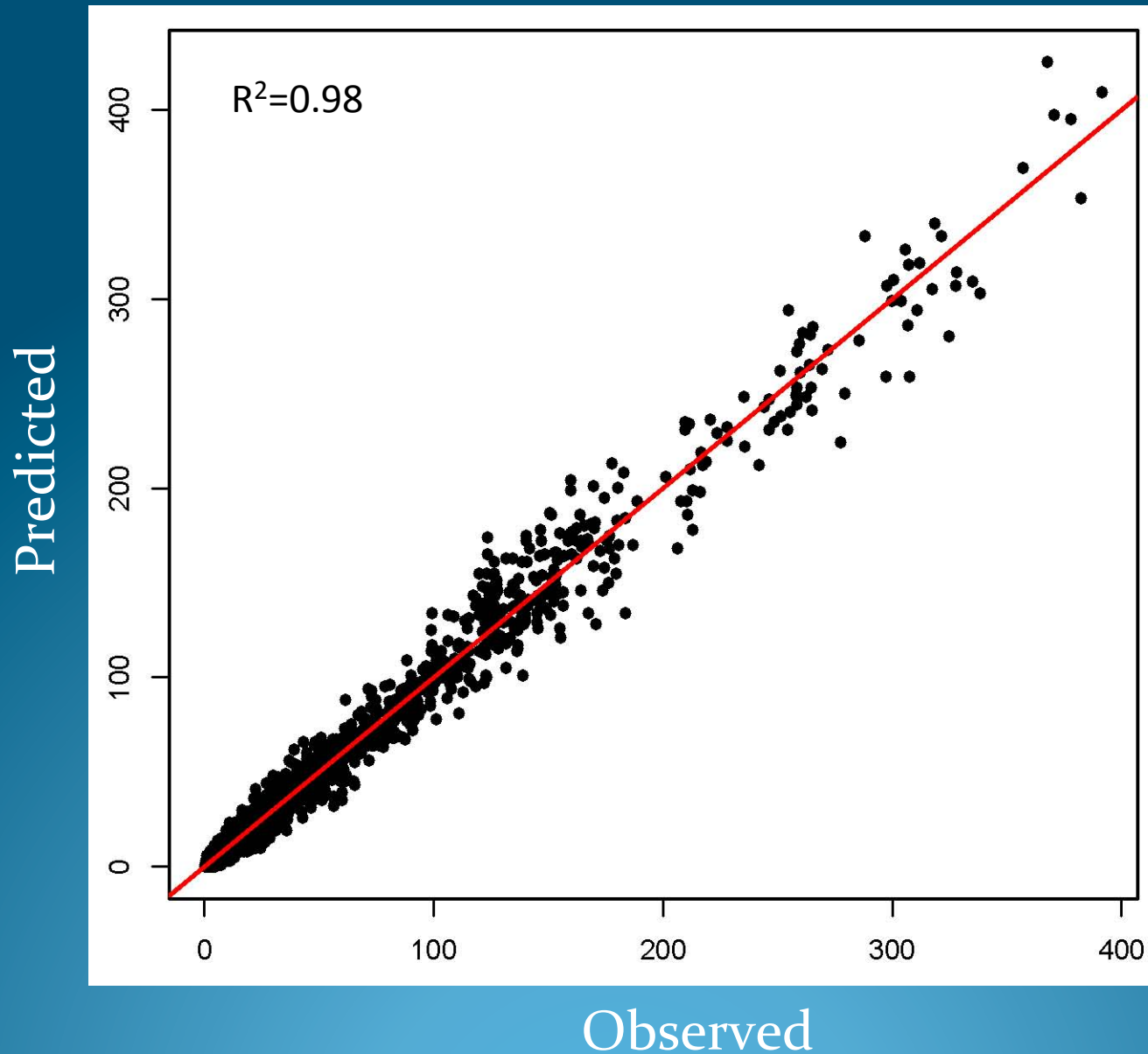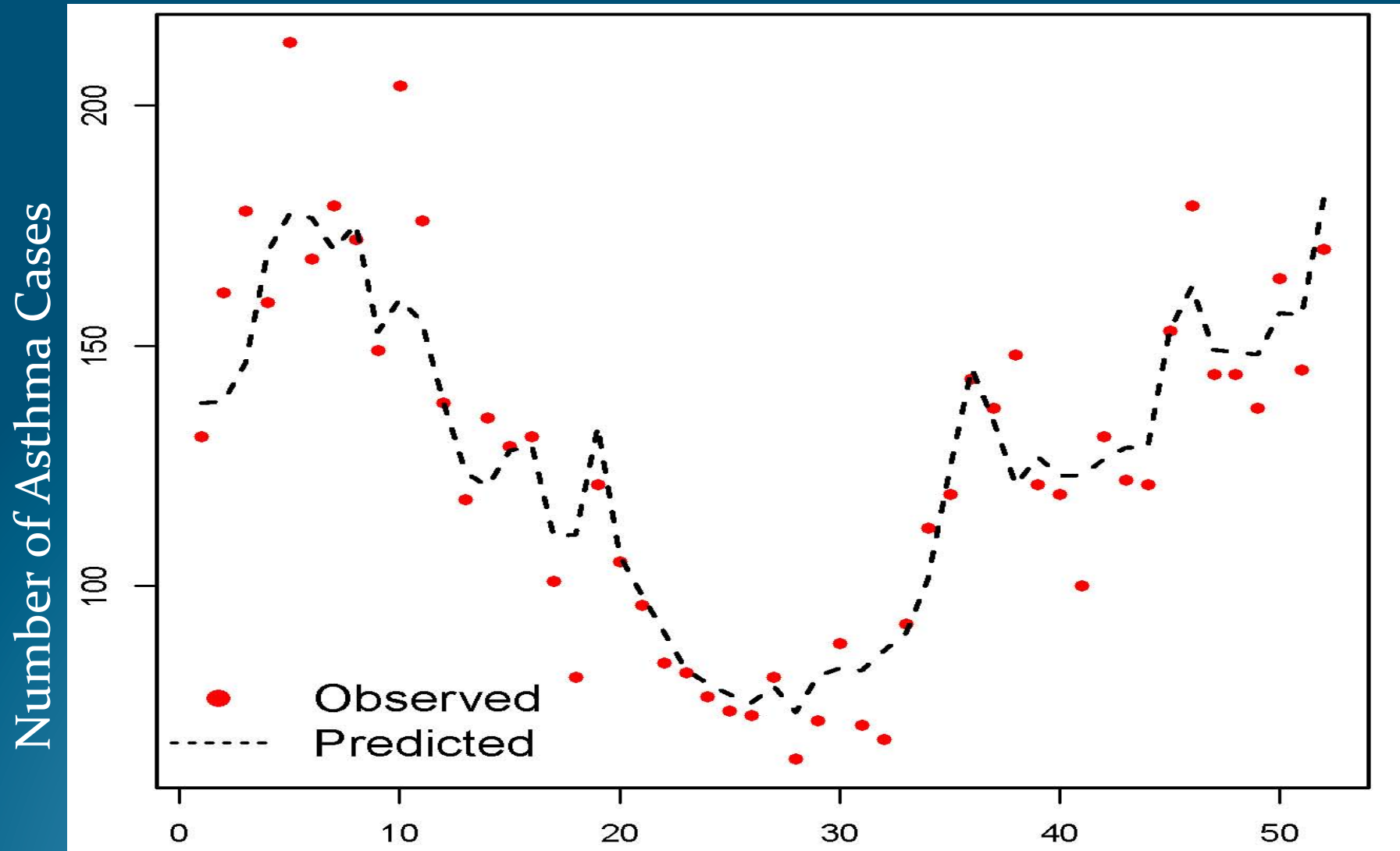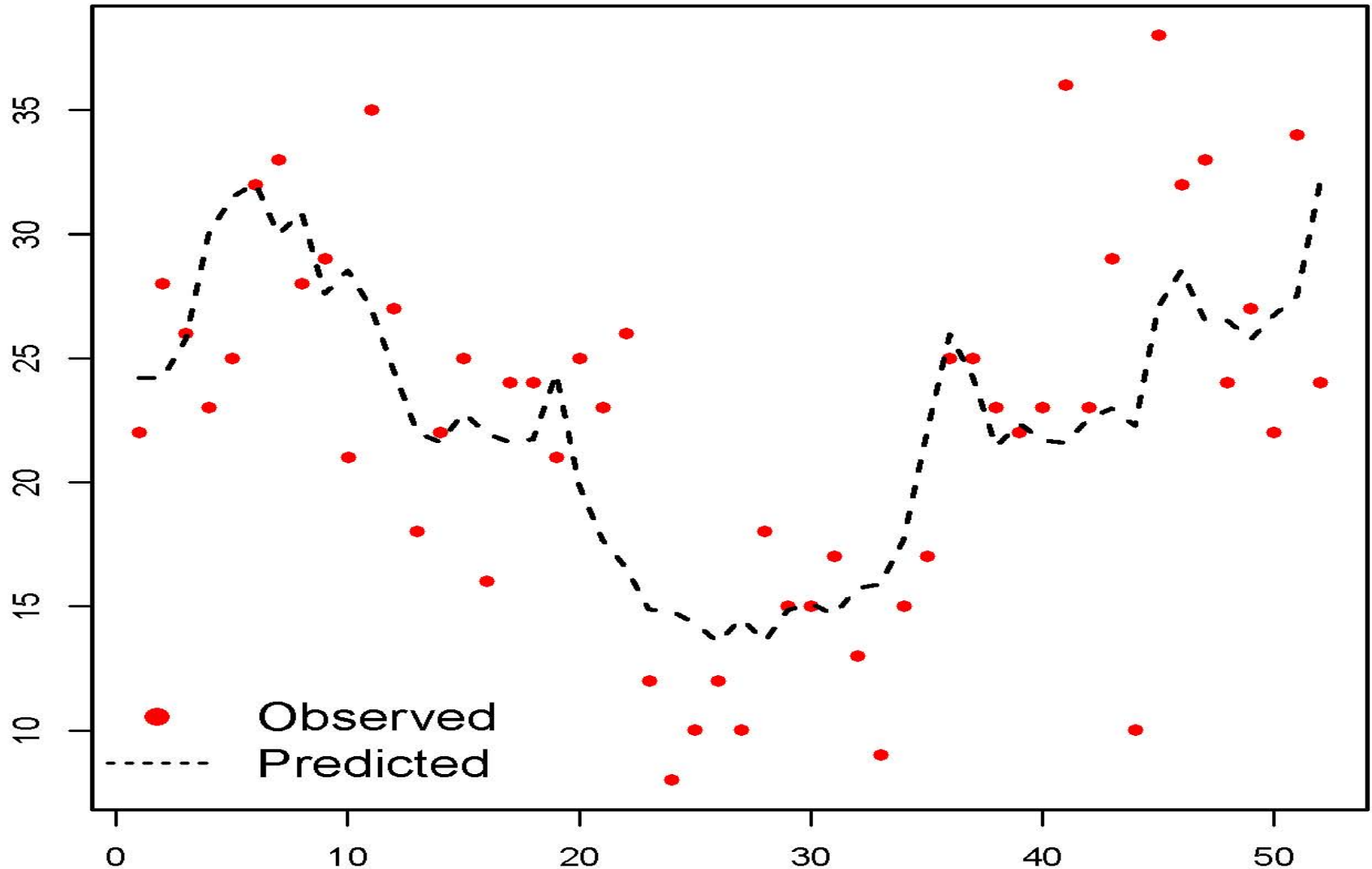
Miami-Dade County
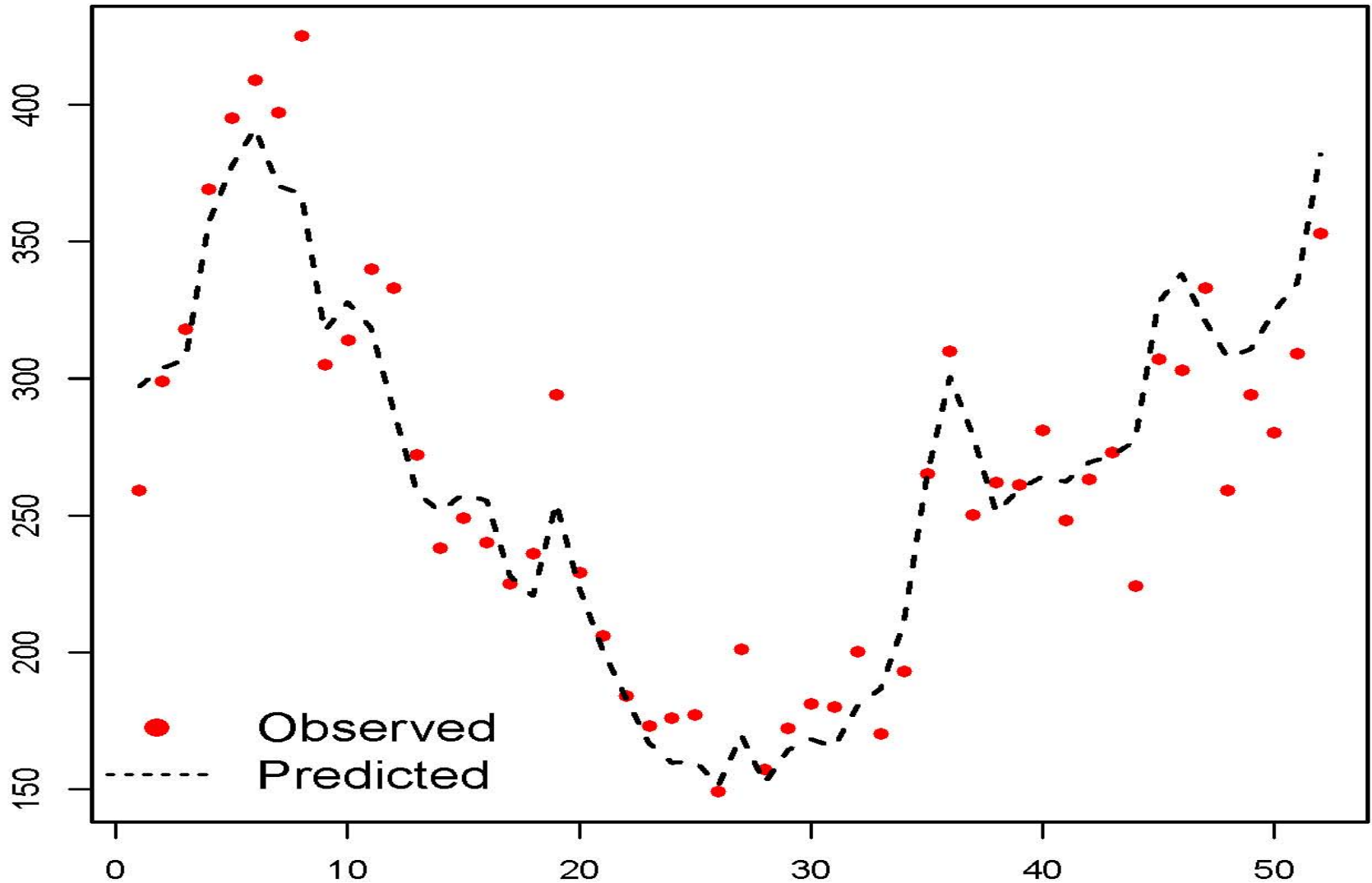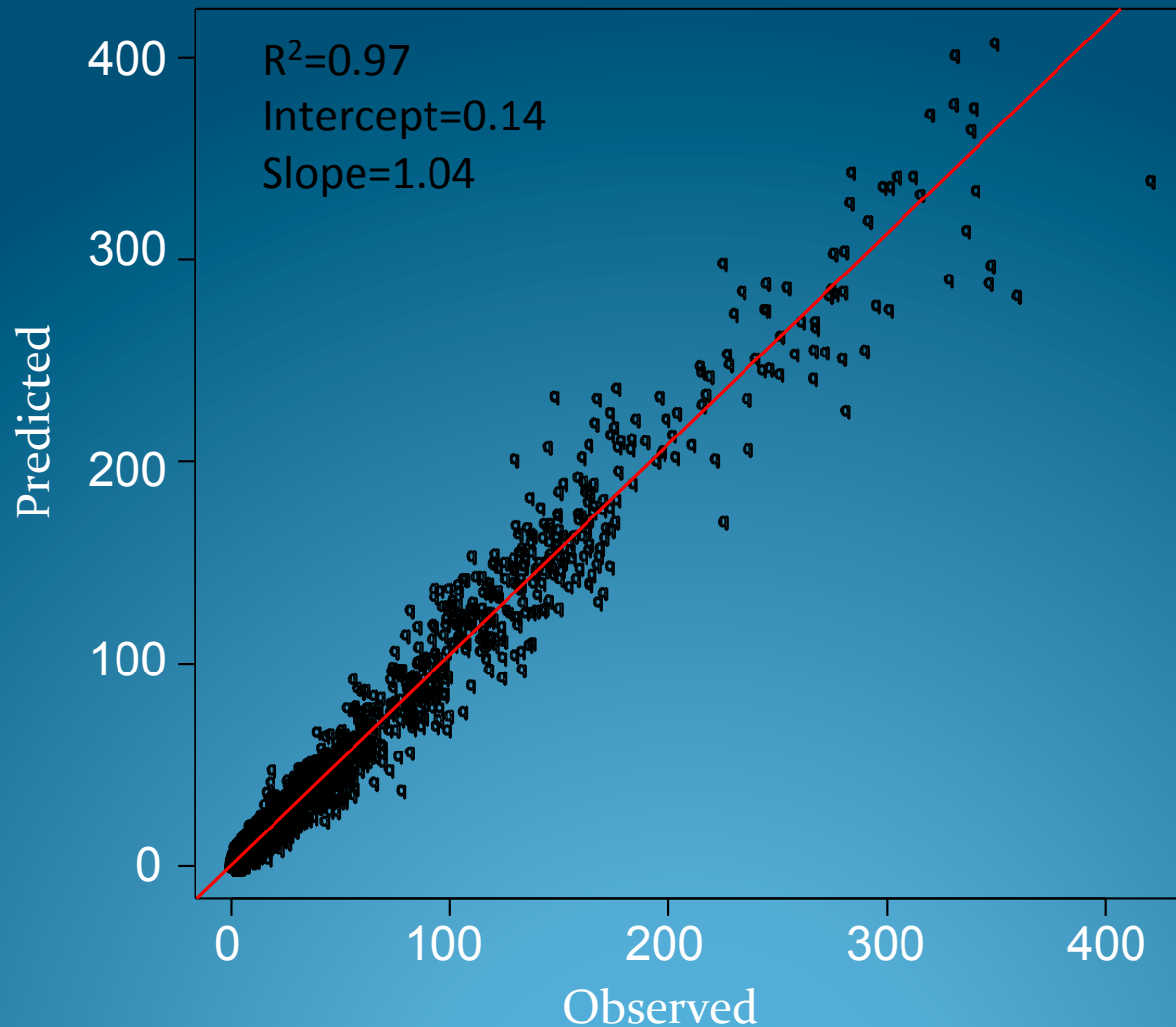
Hillsborough County

Week in 2007

Alachua County

Week in 2007

Initial Conclusions

- $PM_{2.5}$'s association with the number of asthma cases depends on both age and sex

- Smoke is associated with the number of asthma cases, above that due to $PM_{2.5}$, and that association depends on age and sex

Model Validation Using 2008 Data

Challenge and Way Forward

- The model with only time and random effects for county fit as well as the model that also included the environmental variables such as $PM_{2.5}$, smoke and fire.

- This could be due to the fact that 2008 was a year with a low incidence of wildfires.

- In 2011, wildfires were severe in Florida. Efforts are underway to secure 2011 asthma data to assess whether the environmental variables are more important when the incidence of fires is higher.

Project Timeline

Study	Task Numbers and Description	First Year				Second Year			
		1st Q	2nd Q	3rd Q	4th Q	1st Q	2nd Q	3rd Q	4th Q
1	Production of Environmental Data Sets								
2	Linkage of Health, Socio-demographic and Environmental Data								
3	Investigate Use of Hospital and ER cases of Asthma as Health Outcome Indicator								
4	Assist in developing Public Health Policy Based on the Health Outcome Indicator								
5	Integrate with the FEPHT Program's State Portal								

Milestones Accomplished This Past Year
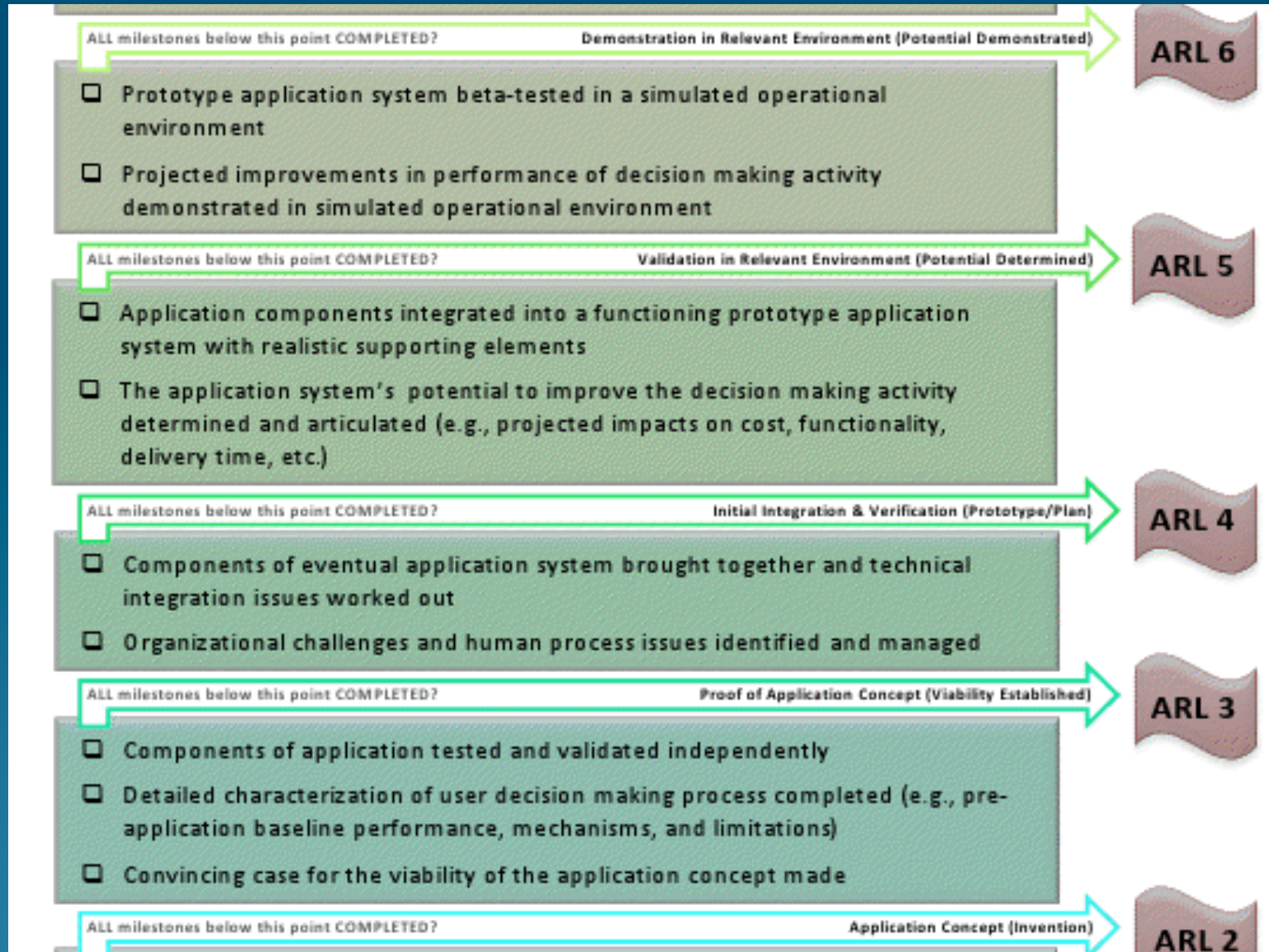
Future Work

- Validate the model for 2011 asthma

- Integrate results into Florida's Environmental Public Health Tracking website

- Establish guidelines for county-level health alerts based on $PM_{2.5}$, smoke and other environmental factors.

Thanks!